Anomalous Radioactivity on the SNO Acrylic Vessel

A. W. P. Poon, N. Oblath, Y. D. Chan, X. Chen, K. T. Lesko, A. D. Marino, E. B. Norman, C. E. Okada, Y. Opachich, S. Rosendahl and R. G. Stokstad

In the analysis of the low energy background in the SNO detector, an anomalous "hot spot" was identified on the acrylic vessel (AV). Figure 1 is a z-x projection of the reconstructed low energy events in the proximity of the AV. The origin of this hot spot is unknown, but its location is directly underneath one of the calibration ports in the detector. The event rate from this hot spot is found to be constant over time.

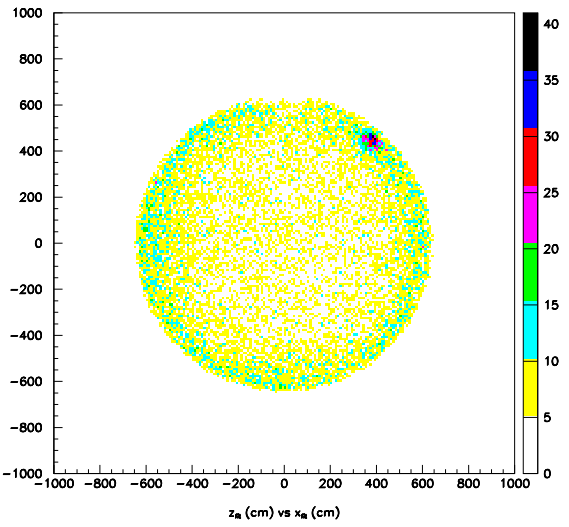

Figure 1: A z-x projection of the reconstructed vertices near the AV.

Events originating from the hot spot have an energy distribution that is expected for embedded radioactivity from the natural U or Th chains. To establish the radioactivity of the hot spot one needs to subtract out the bulk radioactivity. Different monitoring windows centering on different parts of the AV were used to establish the level of bulk radioactivity. Figure 2 shows the good correspondence between the bulk-radioactivity-subtracted and the simulated characteristic distributions of the hot spot.

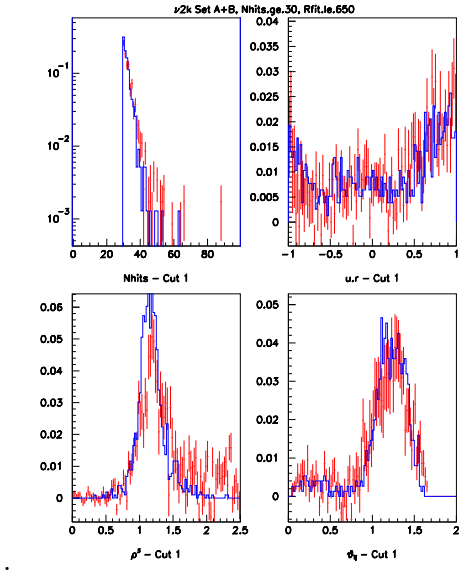

Figure 2: Comparing the hot-spot and the simulated characteristic distributions: *Top Left*: Number of PMT hits; *Top Right*: Reconstructed event direction (outward=+1); *Bottom Left*: radial distribution $(R/600)^3$; *Bottom Right*: Light isotropy.

Using the data from a weak Th calibration source (67.7 mg of Th) deployed in the vicinity of the AV, the radioactivity of the hot spot was calibrated. The dominant systematic uncertainty in this calibration is in the energy spectrum due to the unknown location of the hot spot—there is a significant difference in the detector response between events that are originated from the inner and the outer surfaces of the AV. The activity of the hot spot is estimated to be:

$$m_{hotspot} \;=\; 9 \pm 3\,(\text{stat.})^{+20}_{-5}\,(\text{sys.})\,\mu\text{g Th}$$